The Coal Problem*

By E. G. Bailey, '03

The biggest and most important question before the American people today, is the coal problem. Some may disagree and claim that it is transportation. But sift the present situation to the bottom, and you will find that the coal problem, or rather the abnormally high percentage of ash and impurities in the coal, is like sand in the bearings of transportation, of ocean shipping and of practically all industries, slowing them down at the most critical time in our history.

Coal is bought solely for the combustible element it contains. The less ash and impurities in the coal, the less number of tons you need. The greater the demand for coal, the higher the price and, under present conditions, the poorer its quality. The price has been regulated but the quality has run riot.

Why have we allowed this to happen just at the time when we need *heat units* in their most concentrated form? Why are the railroads burdened today with hauling millions of tons of utterly worthless dirt that anyone can dig up from their back yard or have from any rock pile for the asking? To say that this excess of ash and other impurities in the coal coming on the market today is worthless, does not describe the situation. The price paid for this dirt is only a small fraction of the damage. The rest of its cost is in the decreased efficiency, the lowered capacity, the increased labor and the excessive repair bills involved in the combustion of this coal,—and in the necessity of closing down industries because of the lack of the coal which might have been shipped in place of these so-called "worthless," but really exceedingly costly impurities.

Impurities In Coal

Through the past winter we have heard a great deal of talk about the deterioration in the quality of coal, the increase of ash, slate, sulphur and other impurities. We know this has occurred, but let ue see how much it has amounted to, how much it has cost and we can decide better what efforts should be put forth and what expenditure made to remedy this difficulty.

We find from reliable sources that the coal received in many of the largest power plants in the country has increased by 5% to 10% in ash and has decreased in heating value by 8% to 12%. Figures from a prominent manufacturer, who has received coal from the same district during the past seven years and has followed its quality closely by analysis and other means, show a decrease of 9% in B. t. u. during the calendar year 1917 as compared with averages of five years, 1911 to 1915 inclusive.

War conditions should be borne in mind in this connection. We should not assume that the quality of all coal mined has decreased in this same ratio, for the Navy and other Government requirements have increased by several million tons, and they rightfully are getting the better coal. Hence, some of the decrease in the quality of coal going to industrial plants and locomotives has been due to confining their supply to the mines of inferior quality. But evidence is at hand to show that coal coming from the same mines carries a much higher percentage of bone, slate and free impurities than it formerly did, and as a conservative estimate I am confident that the increased coal consumption of this country during het year 1917 due to the inferior quality resulting from neglect of preparation at the mines, tipples and breakers amounted to at least 5%. In other words, of the approximately 600,000,000 tons of coal produced and shipped to market during the past year 30,000,000 tons of it was perfectly worthless dirt, slate and rock.

Cost of Dirty Coal

How much has this increase in impurities in coal cost the United States during the past year? In the first place coal has been worth on an average, counting contracts and all, about $2.50 at the mines. The average freight, including both rail and vessel, paid on all coal produced is probably in the neighborhood of $1.50 per ton. So that the 30,000,000 tons of dirt which has been delivered to the consumer has cost about $120,000,000 during the past year.

But this only takes into consideration the cost of the coal delivered to his plant. He then has the additional cost of firing this inferior coal, repairing furnaces, stokers, locomotives and the cost of handling the ashes.

Coal Shortage or Dirt

We have been talking about the coal shortage, while in reality we have been loading our cars and locomotives with slate and impurities instead of coal, and had coal of the former quality been shipped to market, we would have had 300,000,000 tons more real coal than we did get.

The effect of this increase in the percentage of ash has been cumulative. Storage piles have been gradually exhausted and the supply to consumers has diminshed to absolutely nothing in many cases due to each day's coal consumption requiring 5% more than it otherwise would, because of the high percentage of ash alone, regardless of weather conditions or increased load. Sup-

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pose that all of the slate and impurities corresponding to this 5% increase had been concentrated into two or three weeks of normal shipments during the middle of the winter and this 30,000,000 tons of pure slate and rock were loaded into 1,000,000 railroad cars without any coal mixed with it. Every American citizen would have been up in arms in a minute, and indignation societies and vigilance committees would have emptied the slate out along the railroad tracks and started the empty cars back to the mines to be loaded with coal instead of impurities. But the final result has been the same.

In buying coal we have been so accustomed to expect the quality to decrease when the price went up that we considered it inevitable. We thought there was no remedy. The coal operator has not been wholly to blame, because he could not control the preparation of coal at the mines of his competitors. If he was conscientious and prepared his coal, he was the loser and the man who shipped dirty coal to the market obtained his profits.

The cause for this condition is well known to anyone at all familiar with the mining of coal; the reason is that the technically trained men of this country have failed to master a difficult problem they tackled several years ago and would have mastered by this time, had they had the courage of their convictions and the ability to handle human nature problems as well as engineering.

Why Quality Decreased When Price Increased

There was an increased demand for coal in 1916. Naturally, prices commenced to soar, and many consumers foresaw what was coming and were glad to pay any price in order to get coal and fill up their storage space. This condition continued through the winter of 1916-1917 until it was of common occurrence to pay as high as $5.00 and $6.00 per ton for bituminous coal at the mines. Most of the purchasers were so anxious to get coal that they forgot all about quality and were willing to take anything at any price, in order to keep their plants in operation. Many of them who were buying their coal on an analysis basis discontinued the practice, fearing that otherwise another purchaser might obtain some advantage over them in securing *quantity* of coal

It is only logical, under such conditions for the mine operator to ease up on the preparation of coal at the mines. He has ample market at a high price for every ton of coal which he can load. He wants to keep every miner in his employ and attract more from other mines to load railroad cars as fast as they are placed at his tipple. If he compelled the miner to prepare the coal as he previously did, the miner would pick up his kit of tools and go to work in a neighboring mine where the cleaning of the coal was not demanded. His competitor would then be able to fill high-priced orders while the operator who lost the miner would be restricted as to his capacity. Therefore, why should the miner or why should the coal operator pay any attention to the quality of coal he is producing when the man who is buying it is offering fancy prices and crying for more tons of anything that is black.

Some may think that the price of coal at the mines as fixed by the Government in August 1917, being lower than the operators considered justifiable, had something to do with the decrease in quality. It may possibly have affected the preparation of coal in a few instances where the operator was forced to reduce his costs as much as possible, but if the Government price were advanced on the present basis of control to $5.00 per ton at the mines, it would not reduce the percentage of impurities in the coal one iota.

What Is The Remedy?

To simply request the coal operators to give the coal better preparation and instruct the miners to carry it out, even appealing to them on the grounds of patriotism, will not accomplish the results. There is too much selfishness in some of us and too much human nature in all of us to expect a man to start his coal picking table, his washer and other means of eliminating impurities that will add a cost of 10 to 50c per ton to all the coal he produces when in the end he gets no more pay for his product that the operator who has recently opened a "snow bird" mine and has no equipment, except labor, to clean his coal, or the slacker who makes a pretense of doing it, and is in reality loading the heaviest material he can find.

We must go to the very root of the matter, and during the present crisis eliminate every possible pound of slate and impurity from the coal as it is loaded into the railroad cars at the mines. This will be equivalent to increasing the motive power, the car supply and terminal facilities of our railroads to the extent of 30,000,000 tons carrying capacity per year. It is possible; it can be done; and it *must* be done. The question remains how to do it most quickly and at least expense. In reality we should not hesitate at the expense of carrying this out for it will be cheap at any price.

You must bear in mind that increasing the price alone will *not* improve the quality and without the quality being improved the railroads can not haul the necessary heat units. There is enough labor available at the mines to clean the coal, our trouble is due to lack of railroad facilities to haul the excessive amount of impurities it contains. It seems so perfectly self-evident that

we must put forth every effort to concentrate as many heat units in each ton of coal which our railroads can handle, that in the face of these figures we can go to any end in carrying out the remedy. This question is important enough to do the job right and everything which is worth while, *can be done.*

PAY PRICE IN PROPORTION TO QUALITY

The remedy is to establish a standard quality and then determine the real quality of coal as shipped from the different mines each month, and provide inducements to the operator for producing clean coal. There is no time nor need for going into refinements, but we must concentrate on the basic factors and strike them hard. The other difficulties of less importance will tend to be corrected at the same time. The main factor is ash, particularly the free ash in slate, bone, sulphur balls and extraneous impurities. Of secondary importance is the question of intrinsic asn in the coal itself. The percentage of ash in the coal should be determined each month from every shipping mine, particularly those in the Appalachian field, which is the nucleus of our difficulties. This might seem like an impossible task, but it is not.

I would recommend that the Government establish coal sampling stations at certain points where large numbers of railroad cars are unloaded to vessels or power houses. These sampling stations should be equipped with the necessary machinery for handling samples of 1000 lbs. or more so that the sample will be thoroughly representative of the individual car from which it is taken. From this sample determine the percentage of total ash as well as the free impurities (slate, rock, etc.) so that a positive check will be obtained on each mine as to the quality of coal being produced, and especially the effectiveness of its preparation.

By locating these sampling plants at such points as New York, Philadelphia, Baltimore, Hampton Roads, Cincinnati, Lorain, Buffalo and other lake loading ports, adding Chicago, St. Louis, Indianapolis, Birmingham and other cities throughout the United States later on as the work extended, coal from every mine in the adjacent districts can be consigned or reconsigned by the Fuel Administration to these cities and to these particular piers and power plants so that at least one sample each month will be obtained from every mine shipping coal. Later on as the system is perfected it could be increased to the sampling of one car out of every ten shipped, so that a very fair average of the quality of coal loaded from each mine would be obtained. Even though not enough cars could be sampled to get an average that would be scientifically accurate to a fraction of one percent, the influence on the operator and miner would be effective. He would not know which car or cars were going to be sampled. He would have a strong inducement to prepare every car of coal loaded at his tipple the same as if he knew it would be tested.

To give the coal operator a real incentive to clean his coal as he should, the price he receives for his coal should be materially affected by the quality of coal produced. It would be advisable to go a step further and base the distribution of cars to the mines on quality also. The quality as shown by the results of one month should form the basis of price and car distribution for the subsequent month, so that no confusion resulting from back charges and adjustments need interfere with the plan.

WHERE HEAT IS WASTED

Let us forget for a minute much of the detailed theory and ideas of combustion and come down to a few basic facts. Coal is fired to the boiler furnaces to produce heat. Whatever the heating value of this coal may be, whether it is 10,000 or 14,000 B. t. u. per pound, that figure represents 100% of the heat units available for making steam in that boiler. The problem is to transfer as many heat units as possible from the coal to the steam. All of this heat can not be utilized, but it does all show up some place and the channels through which this heat passes may be divided into three general classes:

1. Incomplete combustion (loss).
2. Heating up flue gases and other things beside water in boiler (loss).
3. Evaporating water in the boiler (useful).

The entire 100% of heat, no more and no less, always shows up in these three main items, which may be called a heat balance.

The amount of heat in the third item represents boiler efficiency and it must be low if the other two items are high, and it can be high only by keeping the other items low. These two loss items are such that they get first chance, so to speak, at the heat units in the coal and high boiler efficiency can only be assured by knowing what are these controllable losses, and how to keep them at a minimum.

KNOWLEDGE AND ETERNAL VIGILANCE

In connection with the operation of power plants there are two old quotations that exactly fit, and I urge everyone to bear them in mind in connection with their own plant. The first one, "Knowledge is Power" is certainly applicable. You *must know* what your plant is doing, you must know what is the efficiency of your boilers and furnaces, what and how much your losses are before intelligent steps can be taken to apply remedies. If you simply know that the efficiency is poor you can not improve it until you know

why it is poor. If there are big losses in the first item of the heat balance mentioned above, you should do one thing. If they are in the second item, you should apply some other remedy.

The other quotation "Eternal Vigilance is the price of Economy" is equally pertinent. Many people have spent much time and money making an extensive series of tests in their power plants, and by means of such tests obtained very good evaporation and high efficiencies which pleased them greatly. The results were tabulated for blue prints or framed in their office, and many of them are foolish enough to think that their plant is still producing this kind of results. Some of them are, and some of them are even getting better results today than they were during such tests, but this applies only to those who are using eternal vigilance and hecking up their efficiencies as well as their losses from day to day and hour to hour. As George Diman says, "A boiler test is a good deal like a horse race,—you can get most anything you want out of it, but you keep on burning coal 365 days of the year."

Importance of Coal Industry

The things which have happened during the past year in connection with the coal industry have served to waken the engineers as well as the general public to the importance and magnitude of the coal problem. It not only needs the most careful attention and the most diligent study today, but it needs the continued service of the technically trained men of this country to follow it up in the future, for it always will be a problem of greatest magnitude in the United States. We have been bountifully supplied with hundreds of thousands of acres of coal of good quality, we have been mining it so cheaply, and thinking so little of the future that most people have not realized what tremendous problems were involved in it and how important they were to the industrial and physical welfare of the country.

Most people have the impression that we have a practically unlimited supply of coal and that when it is gone there are infinite quantities of undeveloped coal lands in China or other parts of the world. Others have thought that water power or some miraculous form of energy would be developed to replace the need of coal, but the occurrences of the past twelve months have caused us to think more deeply on these subjects. Investigations have shown the fallacy of these substitutes and impressed upon us the necessity of knowing more about our coal industry.

One of the most important problems is the relation between price and value of coal. This has not yet been satisfactorily or equitably determined, for it involves a third factor, namely conservation of our natural resources which should enter into this relation and the working out of this phase of the coal problem alone will require a great deal of attention by the best brains of the country. It should be undertaken and put on some intelligent basis as soon as possible after the war ends and conditions return to something like normal.

Another illustration of a single phase of the coal problem which is deserving of further attention is the simple question of coal storage. This always has been a serious problem, especially for certain coals when stored in certain parts of the country. Following the war it is going to be more so, because people who have been handicapped now are going to store larger quantities of coal as soon as they are able to get coal to store, but what is the use of storing coal if they are unable to prevent expensive losses due to spontaneous combustion.

Solution Needed for Future as Well as Immediate Problems

I, therefore, urge you students of The Johns Hopkins University and young men from other schools to give the coal problem in its various phases your most earnest consideration in selecting your life work or at least your first job, because there is no more important problem today, and there is no richer field for the future, than to tackle some phase of this important industry and bring to light and establish as facts many of the traditions which have been drifting along for so many years without knowledge as to their control and application in normal times, or even in emergencies like that of the present day.

The problems which concern us most are those of the immediate future. Are we going to have coal enough to see us through the coming winter? The present indications are that unless some radical steps are taken immediately, the coal shortage will be much worse than it has been. To be satisfied with preferential shipments and permit many of our basic industries to close down is to play the quitter's game, when by concentrating our efforts on loading clean coal at the mines and improving the efficiency of its combustion in furnaces we can have ample coal for all, thereby helping instead of hindering the Thrift Campaign.

We have heard the argument that we should be patriotic and be content with inferior coal, old culm banks and other refuse fuel the same as we are with wheat substitutes in our bread. But the Food and Fuel problems are very different. Economy in their use applies equally to both, but the neck of the bottle of the food question is production, while the weakest link of the coal problem is transportation. It is a crime to burden our railroads with hauling dirt when it is within our power to ship clean coal and supply heat units in their most concentrated form.